Research Article

Study on the Chemical Constituents of Land Cultivated Soil Sample from Two Selected Areas (Pyin Oo Lwin Township)

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Abstract: Physical, chemical and biological changes takes place continuously in soils by climatic forces and influence the efficiency of any fertilizer application. In this research work, soil samples were collected from two different places of Pyin Sar and Thon Daung villages, Pyin Oo Lwin Township in Mandalay Region for physical and chemical analyzed. The soil samples were taken from 12" depth to get the parent material in the soil. The color of soil sample 1 is brown and sample 2 is pale brown. The comparison of the properties of soil samples were done and analyzed. Therefore, physical and chemical properties of soil such as texture, moisture, pH, color, humus, organic carbon, and cation exchange capacity were determined. In addition, chemical analysis of soil samples were made in order to determine their N, P, K content due to agricultural point of view. Each sample were determined at the department of agriculture (Land Use).

Keywords: Physical properties, Chemical properties, (N, P, K) content, agricultural view.

I. Introduction

The upper layer of earth in which plants grow is called soil (Barrera and Aristorenas, 1954). Soil contains the mixture of 45% mineral matter, 5% organic matter, 25% water, and 25% air (Buchter, 1991). Soil is one of the most important natural resources for sustaining biological life, and it plays an important role in agricultural production (Ajibola, 2018). Soil support a number of inorganic and organic chemical reactions. Many of these reactions are dependent on some particular soil chemical properties (Ministry of Education, 1992).

Compounds of aluminium, silicon, calcium, magnesium, iron, potassium and sodium are chief inorganic constituents of soils and also contain small quantities of several other inorganic compounds, such as boron, magnesium, copper, zinc, molybdenum, cobalt, iodine, fluorine etc. The amounts of these chemicals vary in soils of different places. The organic component of soil contains compounds of carbon, hydrogen, oxygen, phosphorus, nitrogen, sulphur and small amount of other elements also (Nikita, Properties of Soil Microbiology).

The physio-chemical properties of soils have been attributed to natural and anthropogenic causes; the natural causes being mostly related to the underlying bedrocks, and the anthropogenic causes to land management practices (Wienhold *et al.*, 2004; Yoo *et al.*, 2006; Verachtert *et al.*, 2009). Soil structure also reveals the colour, pH, texture and chemical composition of soil aggregates. Soil structure is influenced by air moisture, organic matter, micro-organisms and root growth. In addition to effects on plant growth, metal ion solubility,

microbial activity and clay dispersion are also influenced by soil pH (Haynes and Naidu, 1998).

The negative surface charge on clay particles increases with pH increasing particle repulsion. Therefore, controlling soil pH is important in soils with dispersive clays (Chorom *et al.*, 1994). Soil texture are important physical characteristic of soil which is used in both the field and laboratory to determine classes for soils based on their physical texture. The soil texture depends upon the proportion of the constituents solid particles of different sizes (Barrera and Aristorenas, 1954). Many studies on the indices of soil degradation, including nutrient losses, deterioration in soil quality and soil pollution, showed that poor farmland management can pose significant threats to food security in many regions of the world (Malhi *et al.*, 2001; Lavelle *et al.*, 2001; Liebig *et al.*, 2004). Most studies have used nutrient balances to assess the degree and extent of nutrient depletion; these have created awareness but suffer methodological problems as several of the nutrient flows and stocks are not measured.

Soil is one of the factors in growing crop and most research on soil are paid attention on its fertility. This research focuses on the assessment of soil fertility decline using soil chemical data (pH, organic C, total N, available P, cation exchange capacity (CEC), and exchangeable cations) that are routinely collected in soil from Yatanarpon Teleport near Thon Daung village and Yatanarpon Cyber City ,Pyin Sar Village, Pyin Oo Lwin Township in Mandalay Region. The aim of this research is the determination of chemical constituents of land cultivated soil sample from two selected area. The objectives of this study were to investigate soil type, potentiality and reaction in relation to the scattered remaining vegetation species, and to quantify soil suitability for growing field crops.



Figure 1. Location map of Pyin Oo Lwin Township

II. Materials and Methods

1. Sampling and Preparation for Soil Samples

1.1 Soil Sampling

Two samples were taken from two different places of Pyin Oo Lwin Township for chemical analysis. These samples were brought from the depth of twelve inches of the surface using shovel.

1.2. Soil Drying

The soils were dried on the paper sheet about two weeks and allowed to dry in air.

1.3. Grinding and Sieving

Gravels, roots and pieces of macro-organic matters were discarded and the remainders soil were grinded large lumps were broken up by hand and then the soils were sifted by using a 2 mm sieve. The soil that larger than 2 mm will remain on the sieve cannot be analyzed.

1.4. Storage of Soil Sample

The soil samples were stored in the bottle and labeled with laboratory number.



Sample (1)Sample (2)Yadanarpon Teleport (near
the Thon Daung village)Yadanarpon Cyber City
(near the Pyin Sar village)Figure 2. Collection of the soil samples

2. Determination of Moisture

Constant weight of porcelain basin was first determined. Then about 5.00 g of sample was placed in basin and weight accurately. It was allowed to dry in electric oven at 105°C. Then it was cooled in desiccator. It was done to constant weight. From the loss in weight, the percentage of moisture of the sample under analysis was calculated.

Calculation

Mass of basin = W_b Mass of basin + soil = W_1 Mass of oven dry soil + basin = W_2 Mass of sample before heating = $W_1 - W_b = b$ Mass of sample after heating = $W_2 - W_b = a$ Moisture percent, $M = \frac{(b-a)}{b} \times 100$ Moisture coefficient, $k = \frac{100 - M}{100}$ M = Percentage of moisture

3. Determination of Hydrogen Ion Concentration (pH) of the Water Extract of Sample

About 20.00 g of sample was weighed accurately and placed into a conical flask. Then 50 cm³ of distilled water was added (the ratio of sample to water was1:2:5) and shaken for half an hour. The pH was measured by pH meter. The pH meter was calibrated with pH 4.0 buffer solution before use.

4. Determination of Texture by Pipette Method

About 10.00 g of air-dry soil was weighed accurately and placed in a 500 cm³ conical flask and some amount of distilled water was added. The flask was heated till boiling. 10 cm³ of 10 % sodium pyrophosphate solution was added to disperse the soil colloids and heating was continued for about fifteen minutes after which it was cooled. After cooling, the contents were transferred to a 1000 cm³ graduated cylinder and the solution was made up to the mark with distilled water and then kept overnight to allow the soil colloids to settle. The next day, the contents were stirred for about four minutes, the solution from 9 cm depth was pipetted with 25 cm³ pipette and then it was transferred to a porcelain basin and evaporated on a water bath. From the weighed amount of residue, the percentage of clay and silt were calculated.

After four hours of the stirring, the solution was pipetted with 25 cm³ pipette from 4 cm depth and evaporated to dryness. From this residue, the percentage of clay was calculated. Then, the percentage of silt was obtained by difference. To determine the amount of sand, the remaining solution was poured into 53 cm sieve and the clay and silt were washed with water. The percentage of sand was calculated.

Calculation

Clay % = $\frac{c \times 4000}{s \times k}$ Silt % = $\frac{(b-c) \times 4000}{s \times k}$ Sand % = $\frac{a \times 100}{s \times k}$ a = weight of clay (g) b = weight of silt and clay (g) c = weight of sand (g) s = weight of sample (g) k = moisture coefficient

5. Determination of Organic Carbon and Humus

About 0.20 g of fine soil sample was weighed accurately and put in a clean dry 100 cm³ conical flask. 10 cm³ of 0.4 N chromic acid solution was poured and stirred carefully. Then a small funnel was inserted in the flask and heated on a hot plate to boil faintly. After boiling, the funnel and the neck of the flask was washed with distilled water, 3-5 drops of 0.2 % phenylanthranilic acid was added and titration was done with 0.4 N Mohr's solution until the original cherry violet coloured turned into dark brownish green colour.

The percentage of carbon and humus were calculated.

Calculation

Organic Carbon % = $\frac{(V_1 - V_2) \times N \times 0.3}{s \times k}$

 V_1 = Volume of Mohr's solution for the blank titration (cm³)

- V_2 = Volume of Mohr's solution for the sample titration (cm³) s = weight of sample (g)
- s = weight of sample (g)
- k = moisture coefficient
- N = normality of Mohr's solution

Humus $\% = C \times 1.724$

C = percentage of organic carbon

6. Determination of Available Nitrogen by using Alkaline Permanganate Method

About 20.00 g of soil sample was weighed accurately and transferred into 500 cm³ distillation flask and 20 cm³ of distilled water was added, followed by 100 cm³ of 0.32 % KMnO₄ and 100 cm³ of 2.5 % NaOH solutions. Both reagents were freshly prepared. The contents were distilled into a known amount (10 cm³) of 0.02 M H₂SO₄ until 30 cm³ distillate was collected. Then the excess of acid was titrated against 0.02 M NaOH solution by using methyl red as an indicator. A blank determination was carried out with the same fashion.

7. Determination of Available Phosphorus (Visible Spectrophotometric Method)

About 2.00 g of oven dry soil was weighed accurately and placed in the shaking bottle 400 cm³ of pH 3 buffer solution (ammonium sulphate and sulphuric acid buffer solution) was added and the bottle shaken for half an hour. After that, it was filtered, 50 cm³ of filtrate was pipetted into 100 cm³ volumetric flask. 4 cm³ of 2.5 % ammonium molybdate solution was then added from the burette. This was followed by the addition of 6 drops of freshly prepared chlorostanous acid after which the solution made up to the mark with distilled water. Within 10-15 minutes after adding the reductant chlorostanous acid to the filtrate, the amount of P₂O₅ was monitored at 660 nm using spectrophotometer.

8. Determination of Available Potassium and Exchangeable Sodium (Flame Photometer Method)

About 5.00 g of air-dry soil was weighed accurately and placed in a 100 cm^3 shaking bottle containing 50 cm³ of 1 N ammonium acetate solution. The bottle was shaken for one hour with mechanical shaken and the solution filtered. The amount of sodium and potassium in the filtrate was measured by using the flame photometer.

9. Determination of Exchangeable Calcium and Magnesium (Titrimetric Method)

About 2.50 g of sample was weighed accurately and placed in a 500 cm³ shaking bottle containing 250 cm³ of 1 N sodium chloride solution. The bottle was shaken for three minutes and kept overnight and the filtered.

To determine calcium and magnesium, 25 cm^3 of filtrate was pipetted into conical flask and then 5 cm^3 oammonium buffer solution (pH = 10) was added. Eriochrome Black T was used as an indicator. It was titrated with 0.02 N EDTA solution until the color changed to blue.

To determine calcium, 25 cm³ of filtrate was pipetted into conical flask and then 2 cm³ of 10 % sodium hydroxide solution was added. Murexide was used as an indicator. It was titrated with 0.02 N EDTA solution and the end point color was violet.

Calculation

 $Ca(meq/100g) = \frac{V \times N \times 100}{s \times k}$ V = titrant for Ca (cm³) N = normality of EDTA solution s = weight of sample (g) k = moisture coefficient $Mg(meq/100g) = \frac{V \times N \times 100}{s \times k}$ V = titrant for (Ca + Mg) - titrant for Ca

10. Determination of Cation Exchangeable Capacity by Barium Chloride Triethanolamine Method

10.00 g of air-dry soil was placed in a 125 cm³ conical flask, exactly 25 cm³ of buffer solution (pH = 8.1) was added and the flask allowed to stand for half on hour, mixing the contents occasionally by swirling. The mixture was transferred and filtered into a 250 cm³ volumetric flask by using an additional 25 cm³ of buffer solution to aid in the transfer of all the soil.

The time taken should not be less than 30 minutes to complete filtration and leaching. Then the soils were leached with 100 cm³ of replacement solution (ie. the mixture of barium chloride and pH = 8.1 buffer solution). The filtrate was not used. After that, this barium saturated soil was washed with 150 cm³ of distilled water and the filtrated discarded. Next, the soil was leached with 125 cm³ of calcium chloride solution into 250 cm³ volumetric flask and this filtrate was diluted to the mark.

10 cm³ of this aliquot was taken into a 15 cm³ centrifuge tube, 1 cm³ of 10 % potassium chromate solution was added and placed on a water-bath at 80-90°C. After 20-30 minutes of heating, the tubes were taken to allow to settle the precipitate. After about 2 hours, it was removed from the water-bath and cooled. Then it was centrifuged for 15 minutes at 1700 rpm; the supernatant liquid was then decanted. The mouth of the tube was rinsed and the sides washed down using about 5 cm³ of saturated barium chromate solution.

The precipitates were broken up by using a small glass rod, the rod was rinsed and the suspension centrifuged again and drained. The precipitates were dissolved in 10 cm³ of dilute hydrochloric acid and placed in a 100 cm³ volumetric flask. Then it was diluted with distilled water up to the mark. The spectrophotometric measurement of the prepared solution was made at 425 nm.

III. Results and Discussion

1. Physicochemical Analysis of Soil Sample

In this research work, the determination of soil samples were collected from Thon Daung village and Pyin Sar Village, Pyin Oo Lwin Township in Mandalay Region. The samples were taken from one portion in Yatanarpon Teleport and one portion in Yatanarpon Cyber City. These samples were analyzed by some physical and chemical properties. The data of all samples are described in Table 1, 2, 3, and 4.

Sample	Depth in inches	Moisture (%)	pH (1:2.5)	Color	Humus (%)	Organic carbon (%)
S-1	12	0.75	6.55	brown	3.95	2.29
S-2	12	0.57	5.61	pale brown	0.76	0.44

Table 1. The physical properties of soil samples

From the study of the results in table 1, the pH value of sample 1 is slightly acid and sample 2 is moderately acid. The pH range of 6.0 to 6.8 is ideal for most crops because it coincides with optimum solubility of the most important plant nutrients. Some minor elements (e.g., iron) and most heavy metals are more soluble at lower pH. Lime is commonly added to soil to increase pH often resulting in increased microbial activity and crop yields, and contributing to higher SOM and increased aggregation. The above 7.5 value of pH shows basic nature. The percentage of organic carbon and humus in sample 1 is medium and sample 2 is very low. So the moisture content of two samples are very low.

Table 2. Textural Analysis of Soil Samples						
Sample	Composition					
	Sand (%)	Silt (%)	Clay (%)	Texture class		
S-1	66.20	20.00	13.8	Sandy loam		
S-2	46.20	21	32.8	Clay loam		

According to above table 2, texture type of sample 1 and 2 are sandy loam and clay loam. In sample 1, the percentage of sand are very high. Therefore, it cannot hold the water for long time. It is not suitable for paddy cultivation. However, melon and coconut grow in sandy loam soil. If water is available for irrigation then crops such as maize, millets, barley can be grown in desert soil. Cactus also grows in this soil. The percent of clay in sample 2 is very high so it is good for crops and vegetables cultivation.

Table 3. Some Chemical Properties of Soil Samples

Sample	Available				
	Nitrogen (meq/100gm)	Phosphorus (meq/100gm)	Potassium (meq/100gm)		
S-1	0.25	2.02	0.85		
S-2	0.14	2.01	0.17		

According to table 3, available N value of sample 1 is medium, P value is low and K value is high. In sample 2, available N, P,K values are very low. So, in sample 1 may be added natural fertilizer and sample 2 may be used natural and chemical fertilizer.

	I able 4. Ex	ysis ut sun samples				
Sample	Exchangeable cations (meq/100 gm)			Cation exchange capacity (CEC) (meq/100 gm)		
	Ca ⁺⁺	Mg ⁺⁺	Na ⁺			
S-1	5.37	14.09	0.39	20.69		
S-2	6.04	7.38	0.20	13.78		

Table 4. Exchangeable Cation Analysis of Soil Samples

Exchange	Very Low	Low	Medium	High	Very High
Na	< 0.1	0.1-0.3	0.3-0.7	0.7-2	> 2
Ca	< 0.16	0.15-0.5	0.5-2.5	2.5-5	> 5
Mg	< 0.3	0.3-1	1-3	3-6	> 6

From the results in table 4, in sample 1 and 2, the exchangeable cation of Ca^{2+} are relatively lower than Mg^{2+} and greater than Na^+ . Therefore, crop and vegetable growing are suitable for these region but natural fertilizer should be added to these soils.

IV. Conclusion

Physical and chemical properties of the soil make the decision for the choice of cultivation. Soil fertility is a measure of the ability of soil to sustain satisfactory crop growth in the long-term, and can be determined by physical, chemical and biological processes intrinsically linked to soil organic matter content and quality. In this research work, soil samples were collected from two different places of Pyin Oo Lwin Township for physical and chemical analysis. These result were shown in Table 1, 2, 3 and 4. The pH value of these sample are 6.55 and 5.61 respectively. The two samples are slightly acidic. From textural

analysis of soil samples 1 and 2 are sandy loam and clay loam. The content of available nitrogen and phosphorus are low. So, trace amount of nitrogen and phosphorus fertilizer may be supplied to these soils to cultivate for crops and vegetables. Thus, it is deduced that soil samples can be applied for the cultivation of crops and vegetables. These research will give useful information regarding for that region.

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Conflicts of interest

The authors declare no conflicts of interest.

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